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The Work of the Lick Observatory  
1888-1897.

EDWARD S. HOLDEN.



Reprint from POPULAR ASTRONOMY for August, 1897.







## ASTRONOMICAL WORK AT LICK OBSERVATORY.

EDWARD S. HOLDEN.\*

FOR POPULAR ASTRONOMY.

In your letter of June 26 you ask for some account of the work in progress here for POPULAR ASTRONOMY, which I am very glad to give. A report of the sort is annually made to the Regents of the University of California and from the forthcoming report the following summary is made. It must be remembered that the work of this year is in continuation of previous work, and often in pursuance of plans laid down in 1874—23 years ago. While the resources of the Lick Observatory are large in comparison with those of many College Observatories they are very small in relation to those of the great establishments of Greenwich, Paris, Pulkova, Washington and Harvard College. For instance the whole available income of the Lick Observatory for the coming fiscal year (exclusive of salaries) is \$5,145. This sum must keep all the buildings painted and in repair; keep all our reservoirs and some five miles of underground pipes in order; provide for all painting, plumbing, brick-laying, pipe-fitting, carpenter work, machine work, etc. etc., in the Observatory and in the houses of astronomers and workmen; buy all supplies such as lumber, hay, iron, brick, etc.; pay for all instrument-making not done in the Observatory; pay all freight, express and telegraph bills; maintain a telephone line 17 miles long in good order; pay for fuel; purchase books for the library; provide any needed apparatus for all the instruments; and, this year, buy much of the material needed for an eclipse expedition to India. It is no small task to make the small income cover the requirements. Every want which is felt in a large city is felt here. The circumstances at Mount Hamilton are as different as possible from those at Eastern Observatories. There each person must provide for his own personal comfort; here the comfort of each one must be secured by the expenditure of the annual appropriation. If it is insufficient every person suffers in some degree.

\* Director of Lick Observatory.

The astronomical efficiency of the Lick Observatory cannot be properly estimated without taking such material and social considerations into account. Under the circumstances I do not think it is too much to claim that its efficiency during the nine years of its life has been satisfactory. This has only been attained by good will and earnest effort on the part of all concerned—regents, astronomers, mechanics, workmen. The summary of work for which you asked, is given below.

*Double Stars* have been measured here in past years in great numbers by Professor Burnham, and at the present time Professors Schaeberle, Hussey and Aitken are engaged in such work for parts of their time.

*The Satellites* of Mars, Jupiter, Uranus and Neptune have been regularly observed here for the past nine years by Messrs. Schaeberle, Barnard, Campbell and Hussey. A fifth satellite of Jupiter was discovered by Professor Barnard in 1892.

*The Planets*, especially Mars, Jupiter, Saturn (and also Venus and Uranus) have been systematically observed for their physical features at every opposition by Messrs. Holden, Schaeberle, Keeler, Barnard and Hussey. For several oppositions of Mars the planet has been followed by Messrs. Holden, Schaeberle and Campbell during every available hour.

*Comets* have been discovered here in great numbers. Ten comets (seven unexpected) were discovered by Professor Barnard from 1888 to 1892; five (four unexpected) by Mr. Perrine from 1895 to date. The long series of observations of these and other comets by Messrs. Barnard, Campbell, Hussey, Perrine and Aitken are a contribution to science even more important than the discoveries themselves.

*Comet-Orbits* have been computed here by Messrs. Schaeberle, Campbell, Hussey, Perrine and Aitken; and all comets discovered at the Observatory have had their first orbits calculated by officers of the University. In this work Professor Leuschner, of Berkeley, a former student here, and his assistant, Mr. F. H. Seares, have rendered assistance which is much appreciated.

*Meteors* have been observed and photographed here (and elsewhere) by all the astronomers, and their orbits calculated by Messrs. Holden and Schaeberle.

*Double-Star Orbits* have also been computed by Professor Schaeberle.

*The Zodiacal Light* was regularly observed (visually) by Professor Barnard.

*The Aurora* has been regularly observed (spectroscopically) by Professor Campbell.

*Typical or remarkable Cloud-forms* are regularly photographed by Mr. Pauli, janitor of the Observatory.

*Nebulæ* have been observed (visually, photographically and spectroscopically) by Messrs. Holden, Burnham, Schaeberle, Barnard and Campbell.

*Star maps* have been made and published by Mr. Tucker.

*Photometry*: (photographic and visual)—of eclipses and of stars—has been attended to by Messrs. Holden, Schaeberle, Campbell and Leuschner.

*Solar Eclipses*: those of January and December 1889, April 1893, August 1896, have been observed by Messrs. Burnham, Schaeberle, Keeler, Barnard, Hill, Leuschner and Campbell—and the latter will observe the eclipse of January 1898 in India.

*Lunar Eclipses*.—All lunar eclipses visible here have been observed.

*Occultations*.—A series of occultations has been observed here by Professor Leuschner.

*Transits of Mercury*.—Three transits of Mercury have been observed (either visually or photographically).

*Transit of Venus*—That of 1882 was successfully photographed here by Professor Todd.

*Catalogues of Stars*.—Two such are in progress of preparation.

1st. A catalogue of double-stars and of Coast Survey stars from observations by Professor Schaeberle has been (partly) reduced, on lines laid down by myself, by Messrs. Schaeberle, Campbell, Leuschner, Aitken and Professor Bigelow and Mrs. Updegraff. Professor Aitken has spent more than a year on this work.

2d. A catalogue of 38,000 stars from Washington observations is well towards completion. The reductions have been made chiefly by Messrs. Holden and Aitken. The original observations as printed were full of errors. The final places will be considerably more precise in declination and somewhat less precise in right ascension than the southern zones of Argelander.

*Solar Photography*.—Some 1,800 negatives of the Sun (taken with the photoheliograph) have been secured by Mr. Perrine and since April, 1896, some 450 more by Mr. Colton. Excellent experimental solar photographs on a large scale have been made with the 36-inch telescope and it is hoped to go very much further with this work during the summer of 1897.

*Lunar Photography*.—A very full series of focal negatives has been made with the 36-inch telescope chiefly by Messrs. Holden

and Colton. An atlas on the scale of X-feet to the Moon's diameter has been prepared from these by Professor Weinek at Prague. Enlargements in the telescope have been made by Messrs. Holden, Colton and Perrine and 5 plates of a Moon atlas on the scale of III-feet to the Moon's diameter have already been distributed. Twelve more plates are now in the hands of the engraver and will soon be issued; and about 20 more are ready to be published when the funds are available. The atlas will be complete with about 60 plates. All the work in the dark room is done by Mr. Colton.

*Photographs of the Milky Way.*—A great number of such pictures has been obtained by Professor Barnard who is preparing them for publication.

*Photographs of Planets* (especially of Jupiter) have been regularly made by Messrs. Holden, Schaeberle and Colton.

*Photographs of Comets* have been secured by Messrs. Barnard, Hussey and Colton.

*Visual Photometry.*—Two fine photometers of Professor Pickering's design have lately been given to us by Miss Bruce. They will be used by Professor Aitken, chiefly on double-stars at present.

*Spectroscopic observations* of nebulae, new stars, comets, stars and planets, have been made by Messrs. Keeler and Campbell. The chief problem of the great telescope is to determine the motion of the solar system by spectroscopic observations. It was first attacked here in 1888 and since that time it has been considered as our most important work. The results now attained by Professor Campbell are of unexampled precision, and some of them will be published shortly. Many unexpected delays have occurred in this research which has been under the charge of Messrs. Keeler, Crew and Campbell.

*Time-signals* are sent out daily. Mr. Tucker is in charge of our clocks.

*Meridian-Circle Observations.*—Mr. Tucker has completed a fine series of observations of all stars contained in any of the great *Ephemerides* and *not* contained in the *Berliner Jahrbuch*. This work is all ready to print. He has also determined the places of a long list of stars used by Professor Doolittle to determine the latitude of Lehigh University. The division errors of the  $1^\circ$  spaces of both circles of the instrument have been determined by Mr. Tucker with the assistance of Mr. Aitken.

*Meteorological Observations* (tri-daily) have been regularly made. They are now in charge of Professor Aitken. A summary

of all meteorological observations made here from 1888 to 1897 is in course of preparation by Mr. Perrine.

*Earthquake Observations* are obtained on our two Seismographs which are in charge of Mr. Perrine. A complete list of all recorded earthquakes on the Pacific Coast from 1769 to 1897 has just been prepared by Professor Holden.

*Publications of the Observatory.* The Observatory has already issued three quarto volumes and five octavos beside several pamphlets and the Moon-Atlas. The Smithsonian Institution has lately published an octavo prepared here by Professor Holden—Mountain Observatories—and will probably print his list of recorded earthquakes, just mentioned. Notices from the Lick Observatory regularly appear in the publications of the Astronomical Society of the Pacific. More than 1200 contributions to astronomical and other journals have been made by the officers of the Observatory since 1888.

*Trial of the Crossley Reflector.*—This fine instrument, which had done such good work in the hands of Mr. Common, was presented to the Lick Observatory by Mr. Crossley in 1895. It was completely mounted in June, 1896, and given over to Professor Hussey for trial. The work begun in 1896 is now being prosecuted. Photography in the Newtonian and principal foci will be tried by Professor Hussey, and Professor Campbell has a programme of spectroscopic observations to be carried on with the Bruce spectrograph (constructed here) in the principal focus. A powerful driving-clock (the Bruce clock) has been made here from drawings by Professor Hussey. It is essentially a copy, in little, of the Warner & Swasey clock of the 36-inch equatorial. Its conical pendulum weighs about 56 pounds.

*The Schaeberle 18-inch Reflector* has been used for some years past in experiments in celestial photography by its maker, Professor Schaeberle. Very interesting photographs of Jupiter have been obtained.

*The Crocker Photographic Telescopes* (a pair of Willard portrait lenses) will soon be mounted in a new Dome near the Crossley Reflector. A 12-inch mirror (by Professor Schaeberle) of very short focus is to be mounted on the same stand.

Lick Observatory, July 7, 1897.















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